STEERING COLUMN ASSEMBLY WITH VERTICAL CAPSULES

FIELD OF THE INVENTION

[0001] The subject invention relates to a vehicle steering assembly having release and energy-absorbing components moveable in response to a crash condition.

BACKGROUND OF THE INVENTION

[0002] Energy-absorbing release mechanisms are known for use with collapsible steering columns. Such release mechanisms not only allow the steering column to collapse in response to a sufficiently large impact on the column, but also absorb a portion of the forces generated as a result of such an impact.

[0003] Certain release mechanisms exist in the art that incorporate shear capsules through which plastically deformable shear pins extend. Injected into the capsules during the manufacturing process, the pins shear in response to an impact on the column and release the capsules – and the column connected thereto – to permit the column to collapse. Although such mechanisms are effective in releasing steering columns in response to significant collision events, it would be desirable from the standpoint of both increasing production efficiency and reducing manufacturing costs for the components of such mechanisms to interconnect the steering column with the support structure of a vehicle in a manner that enhances the ability of the mechanisms to withstand force components applied thereto from multiple directions without inadvertently shearing and causing the column to collapse.

SUMMARY OF THE INVENTION AND ADVANTAGES

[0004] The present invention provides a steering column assembly that includes a mounting bracket with a plate having parallel sidewalls extending therefrom. A flange extends laterally from each of the sidewalls for attachment to a vehicle subassembly. The assembly also includes a release bracket having spaced parallel connecting walls interposed between the sidewalls. At least one of the connecting walls has a rearwardly-opening primary notch. A steering column having an outer jacket is carried by the release bracket. A shear capsule is disposed within the primary notch and connected to the mounting bracket. The capsule normally resists collapse of the steering column and shears in response to a collision event for releasing the connecting wall in a direction to collapse the steering column to permit the steering column to collapse. At least one of the sidewalls includes a secondary notch. The shear capsule is connected to the mounting bracket by being disposed within the secondary notch for interconnecting the connecting wall with the sidewall.

[0005] Accordingly, the subject invention overcomes the limitations of the prior art by providing shear capsules disposed within respective pairs of primary and secondary notches for interconnecting a release bracket to a mounting bracket to permit release and collapse of a steering column in response to a crash condition. The manner in which the shape of each primary notch closely conforms to the shape of a selected one of the shear capsules, combined with the close fit achieved by securing the capsule within the secondary notch minimizes dimensional clearance between each pair of aligned primary and secondary notches and the capsule disposed therein. Movement and vibration of the capsules within the pairs of notches is also reduced. This reduces the likelihood that the connecting walls will inadvertently become disengaged from the capsules in response to a force on the

column generated by a source other than the collision event, and discourages premature collapse of the steering column.

BRIEF DESCRIPTION THE DRAWINGS

[0006] Other advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0007] Figure 1 is a perspective view of a steering column assembly according to one embodiment of the present invention;

[0008] Figure 2 is an exploded perspective view of selected components of the steering column of the assembly shown in Figure 1;

[0009] Figure 3 is another exploded perspective view of selected components of the steering column of the assembly;

[0010] Figure 4 is an exploded perspective view of the assembly shown in Figure 1 with the steering column and transmission linkage assembly removed;

[0011] Figure 5 is fragmentary perspective view of selected components in the release bracket of the steering column assembly;

[0012] Figure 6 is a fragmentary perspective view of the release bracket with a perspective view of a shear capsule received disposed within a primary notch;

[0013] Figure 7 is an exploded fragmentary perspective view of the mounting bracket and release bracket with an exploded perspective view of a shear capsule and a connecting bolt of the steering column assembly;

[0014] Figure 8 is a fragmentary perspective view of the mounting and release brackets of the steering column assembly;

[0015] Figure 9 is a fragmentary perspective view of the steering column assembly; and

[0016] Figure 10 is a partial front planar view of the steering column assembly.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0017] Referring to the Figures, wherein like numerals indicate like or corresponding parts throughout the several views, a steering column assembly is generally shown at **20** in Figure 1. The assembly includes a mounting bracket **22** with longitudinally-extending, spaced sidewalls **26**. The sidewalls **26** have inner surfaces **27** facing one another. A flange **28** extends laterally from each of the sidewalls **26** for attachment to a vehicle subassembly. Each flange **28** has spaced holes **30** extending therethrough for receiving complementary bolts (not shown) to attach the flange **28** to the vehicle subassembly. The assembly **20** also includes a release bracket **32** having longitudinally extending spaced parallel connecting walls **34** interposed between the sidewalls **26**. At least one, or as disclosed, each connecting wall **34** includes a rearwardly-opening primary notch **36**.

[0018] The assembly **20** also includes a steering column **38** mounted to the release bracket **32**. An upper jacket **40** is carried by, or as disclosed, integrally formed with the release bracket **32**. The upper jacket **40** extends between forward and rear openings **41** and **42**, respectively. The steering column **38** extends through the upper jacket **40**, and includes an upper shaft **44** having proximal and distal ends **45** and **46**. A control housing **48** is disposed about the upper shaft **48** adjacent the proximal end **50**.

[0019] Referring now to Figure 2, the control housing **48** receives complementary control switches and, where required, associated control arms or other

devices for actuating or otherwise operating the switches. Such switches may include, but are not limited to those for controlling turn signals, lights, windshield wipers and the transmission of the vehicle. An ignition switch assembly **50**, a shift lever clevis **51**, and a tilt lever overmold **52** are carried by the control housing **48**. A compression spring **53**, a force pin **54** and a force pin compression spring **55** interconnect the tilt lever overmold **52** and the control housing **48**. The ignition switch assembly **50** has a bore **56** therethrough, which is aligned with a bore **57** in the housing **48**. A screw **58** extends through the bores **56**, **57** to connect the assembly **50** to the housing **48**. A tilt bumper **59**, tilt spring **60** and spring guide **61** are likewise carried by the housing **48**. As is shown in Figure 1, a rotary connector **62** is disposed about the upper shaft **48** and positioned intermediate the proximal end **50** thereof and the control housing **54** for being operatively connected to a steering wheel (not shown) after the wheel is mounted on the proximal end **50**.

[0020] Referring now to Figure 3, the steering column **38** also includes a lower shaft **64** disposed within a tubular shaft **66**. A cardan joint cage **68** is received within the distal end **46** of the upper shaft **44**. The distal end **46** has holes **70** therethrough. Set screws **72** are disposed within the holes **70** to interconnect the cardan joint cage **70** and the distal end **52**. The lower shaft **64** has an end **74** with a hole **76** therethrough. A connecting pin **78** is disposed within the hole **76** for interconnecting the lower shaft **64** and the cardan joint cage **68**.

[0021] The lower shaft **64**, tubular shaft **66**, upper shaft **44**, a lower column jacket **80**, and a ball retaining sleeve **82** are coaxially disposed within the upper jacket **40** such that the proximal end **50** of the upper shaft **44** extends through the forward opening **41**.

[0022] Referring again to Figure 2, a first inner race **84**, a first bearing assembly **86** and the control housing **48** are disposed coaxially in series about the upper shaft

44. A second bearing assembly **88**, a second inner race **90**, an upper bearing inner race seat **92**, an upper bearing spring assembly **93**, and a bearing retainer **94** are likewise coaxially disposed in series about the upper shaft **44** intermediate the control housing **48** and the rotary connector **62** shown in Figure 1.

[0023] Referring again to Figure 3, the control housing **48** is pivotally connected to the upper jacket **40**. Specifically, the upper jacket **40** includes spaced pivot bores **95**. Pivot pins **96** are disposed within the bores **95** and engage openings **97** on the control housing **48** to pivotally connect the control housing **48** to the upper jacket **40**.

[0024] The upper jacket **40** also includes spaced brackets **98** extending from the forward opening **41**. Each bracket **98** has spaced holes **100** therethrough. A steering wheel shoe **102** is interposed between the brackets **98** and includes bores **104**, each of which is aligned with one of a pair of the holes **100** on the brackets **99**. A spring pin **106** is disposed through each of the two groups of aligned holes **100** and bores **104**. As is shown in Figure 2, a steering wheel shoe lock **108** is interconnected by a shoe pin pivot **110** to the shoe **102** and control housing **48**. An anti-rotation pin **112** is also disposed within the control housing **48** and cooperates with the steering wheel shoe **102**, spring pin **106** and shoe lock **108** to selectively permit rotational movement of the steering wheel (not shown).

[0025] Referring again to Figure 1, a transmission linkage assembly **114** is also carried by the release bracket **32**. The linkage assembly **114** includes a shaft assembly **116**. The shaft assembly **116** is operatively connected to and extends between the shift lever clevis **51**, a shift gate **118** and a lower shift lever **120**. In addition, a shift cable bracket **122** is connected to the mounting bracket **22.**

[0026] The shaft assembly **116** includes an upper shift tube **124**. A U-shaped shift tube clamp **126** secures the upper shift tube **124** to the release bracket **32**. As is shown

in Figure 4, the release bracket **32** includes attachment plates **132** and **134** having bores **136** extending therethrough. Fasteners **140** are received through the clamp **126** and the bores **136** to secure the shift tube clamp **126** to the plates **132, 134**.

[0027] Referring again to Figure 3, the mounting bracket **22** also includes a lower bearing adapter **142** for supporting the steering column **38** and transmission linkage assembly **114**. The adapter **142** has a rear wall **144** with a recess **146** for receiving the shaft assembly **116** therein and a cylindrical housing **148** having an opening **149** therethrough. A shaft bushing wedge **150** is disposed within the recess **146** after the shaft assembly **116** is disposed therein. A bore **152** extends through the plate **24**. A tapping screw **153** is disposed within the aligned bore **152** to connect the adapter **142** to the plate **24**. A lower bearing sleeve **154** interconnects the lower column jacket **80** with the housing **148** about the opening **149**.

[0028] The assembly **20** is shown in Figure 4 with the transmission linkage assembly **114** and steering column **38** removed. The assembly **20** includes shear capsules **170** for interconnecting the release bracket **32** and the mounting bracket **22**. Each shear capsule **170** is removably disposed within a selected one of the primary notches **36** and is fixed to the mounting bracket **22**. The capsules **170** couple and support the release bracket **32** against separation from the mounting bracket **22** in response to application of an axial shear force below a predetermined threshold value. The capsules **170** are also responsive to an axial shear force above the threshold value to cause the capsules **170** separate from the release bracket **32**. This permits longitudinal movement of the release bracket **32** relative to the mounting bracket **22** in the direction of the shear force.

[0029] At least one, or as disclosed, each sidewall **26** of the mounting bracket **32** includes a secondary notch **172**. Each shear capsule **170** is connected to the mounting

bracket **22** by being disposed within a selected one of the secondary notches **172**, which in turn interconnects the connecting wall **34** and the sidewall **26**.

[0030] The primary and secondary notches **36** and **172** have shapes complementary to the shapes of certain of the surfaces of the capsules **170**. As is best shown in Figure 5, each primary notch **36** has top and bottom edges **174** and **176**, respectively, diverging in a rearward direction at a predetermined angle "α" to one another. Each capsule **170** has top and bottom surfaces **178** and **180** complementary to the respective top and bottom edges **174** and **176** of the primary notch **36**. As is shown in Figure 6, the top and bottom surfaces **178**, **180** of the capsule **170** diverge in a rearward direction at the same angle "α" relative to one another as the respective top and bottom edges **174**, **176** of the primary notch **36**. This permits the top and bottom surfaces **178**, **180** to slidably engage the respective top and bottom edges **174**, **176** of the primary notch **36**.

[0031] Referring now to Figure 7, each of the secondary notches **172** has upper and lower edges **182** and **184**, respectively, that diverge in a rearward direction at a predetermined angle "θ" relative to one another. Although the upper and lower edges **182** and **184** may diverge at any angle, the angle "θ" shown in Figure 7 is identical to the angle "α" at which the top and bottom edges **174**, **176** of each primary notch **36** extend. The top and bottom surfaces **178**, **180** of the capsules **170** have grooves **186** therein. The grooves **186** of each capsule **170** slidably engage the upper and lower edges **182**, **184** of a selected one of the secondary notches **172**. The depth "D_1" of each secondary notch **172** is less than the depth "D_2" of the primary notch **32** with which the secondary notch **172** is aligned to accommodate and achieve a conforming fit with the grooves **186** in the capsule **170**. This enhances the stability of the capsules **170** by reducing the likelihood that the capsules **170** will inadvertently shear in the absence of a crash condition.

[0032] Referring now to Figure 8, the assembly **20** also includes tabs **188** for securing the capsules **170** to the mounting bracket **22**. Each tab **188** is disposed on a selected one of the sidewalls **26** adjacent the secondary notch **172** and extends transversely from the sidewall **26** for abutting engagement with the capsule **170**. Each of secondary notches **172** includes an end edge **190** interconnecting the upper and lower edges **182**, **184**. The tab **188** extends from the end edge **190** at a generally perpendicular angle to the sidewall **26**.

[0033] Each tab **188** and capsule **170** have respective bores **192** and **194** extending therethrough. A bolt **196** is received within the bores **192**, **194** to thereby rigidly anchor the capsule **170** to the tab **188**. Although the bolts **196** may extend in any direction relative to the mounting bracket **22**, each bolt **196** extends parallel to the longitudinal axis of the mounting bracket **22**. Positioning the bolts **196** in parallel alignment with the longitudinal axis of the mounting bracket **22** ensures that no net force will be applied to the bolts **196** and transferred to the capsules **170** as result any force component applied in a direction perpendicular to the longitudinal axes of the bolts **196**. This further reduces the likelihood that the connecting walls **34** will be inadvertently released from the capsules **170**.

[0034] Each of the top and bottom edges **174**, **176** of the primary notches **36** includes one, or as disclosed, a plurality of indentations **198**, and each capsule **170** includes one, or as disclosed, a plurality of holes **200**. A shear pin **202** is disposed within each hole **200** and extends through a selected one of the indentations **198**. The shear pins **202** normally resist collapse of the steering column **38** and shear in response to the collision event to release the connecting walls **34** from the capsules **170**.

[0035] Incorporating the secondary notches **172** into the sidewalls **26** of the mounting bracket **22** permits the shear capsules **170** to be anchored within the paired primary and secondary notches **36**, **172** and connected to the tabs **188** using the bores **192**, **194** during

the manufacturing process prior to injecting the shear pins **202** into the holes **200**. This decreases the likelihood that the pins **202** will inadvertently shear or that the structural integrity of the pins **202** will otherwise be compromised during the manufacturing process.

[0036] The release bracket **32** also includes at least one, or as disclosed, a pair of housings **204** that engage the respective connecting walls **34** for receiving the respective capsules **170** therein. Each housing **204** is formed from a parallel segment **206** positioned in spaced relation from a selected one of the connecting walls **34**. Top and bottom wall segments **208**, **210** interconnect the parallel segment **206** with the connecting wall **34** to define a chamber **212** within which a selected one of the capsules **170** is received. One of a pair of integral support arms **214** extends from each of the housings **204** for interconnecting the release bracket **32** with the upper jacket **40**.

[0037] Referring again to Figure 1, the mounting bracket **22** includes a plate **215.** The plate **215** has at least one, or as is disclosed, two guides **216** extending therefrom. Each guide **216** frictionally engages a selected one of the housings **204** for guiding movement of the housing **204** upon release of the connecting wall **34** from the capsule **170**. Although the guides **216** may have any suitable shapes and dimensions, each guide **216** comprises a ridge that extends parallel to the longitudinal axis of the mounting bracket **22**.

[0038] The assembly **20** also includes an energy absorbing mechanism **218** that interconnects the release bracket **32** and the plate **24** for absorbing energy upon movement of the release bracket **32** relative to the mounting bracket **22** in response to the crash condition. The manner in which the energy absorbing mechanism **218** interconnects the release bracket **32** and plate **24** is best shown in Figures 1, 3 and 4. In particular, the plate **24** has openings **220** disposed intermediate the guides **216**. The energy absorbing mechanism **218** includes a housing **222**, which is disposed within one of the openings **220**. A plastically

deformable strap **224** having opposed ends **226** extends from the release bracket **32** through the opening **220** and housing **222** to the exterior of the plate **24**. One end **226** of the strap **224** has a hole **228** therethrough. A connecting member **230** extends from the upper jacket **40** adjacent the rear opening **44**. The connecting member **230** includes a bore **232** complementary to the hole **228**. A screw **234** is disposed within the hole **228** and bore **232** to connect the end **226** of the strap **224** to the connecting member **230**.

[0039] Although the energy absorbing mechanism **218** of the assembly **20** utilizes an S-strap, one skilled in the art will appreciate that other energy-absorbing straps and/or devices may be used, including but not limited to those which employ one or more M-straps, J-straps, other straps, wires, pyrotechnic or other actuating devices, or a combination thereof.

[0040] While the invention has been described with reference to an exemplary embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.